

CLAIMS

1. A corrosion-inhibiting seal for a barrier film comprising a rare earth element and a valence stabilizer combined to form a rare earth/valence stabilizer complex, wherein  
5 the rare earth element is selected from cerium, praseodymium, terbium, or combinations thereof, and  
at least one rare earth element is in the tetravalent oxidation state.
2. The corrosion-inhibiting seal of claim 1 wherein the rare earth/valence stabilizer complex  
10 has a solubility in water of between about  $5 \times 10^{-1}$  and about  $1 \times 10^{-5}$  moles per liter of cerium, praseodymium, or terbium at about 25°C and about 760 Torr.
3. The corrosion-inhibiting seal of claim 2 wherein the solubility in water of the rare earth/valence stabilizer complex is between about  $5 \times 10^{-2}$  and about  $5 \times 10^{-5}$  moles per liter of  
15 cerium, praseodymium, or terbium at about 25°C and about 760 Torr.
4. The corrosion-inhibiting seal of claim 1 wherein there is an electrostatic barrier layer around the rare earth/valence stabilizer complex in aqueous solution.
- 20 5. The corrosion-inhibiting seal of claim 1 wherein the rare earth/valence stabilizer complex acts as an ion exchange agent towards corrosive ions.
6. The corrosion-inhibiting seal of claim 1 wherein the barrier film comprises a compound selected from oxides, hydroxides, phosphates, carbonates, oxalates, silicates, aluminates, borates,  
25 polymers, or combinations thereof.
7. The corrosion-inhibiting seal of claim 1 wherein the rare earth/valence stabilizer complex has a central cavity containing a cerium, praseodymium, or terbium ion and an additional ion.
- 30 8. The corrosion-inhibiting seal of claim 7 wherein the additional ion is  $B^{+3}$ ,  $Al^{+3}$ ,  $Si^{+4}$ ,  $P^{+5}$ ,  $Ti^{+4}$ ,  $V^{+5}$ ,  $V^{+4}$ ,  $Cr^{+6}$ ,  $Cr^{+3}$ ,  $Mn^{+4}$ ,  $Mn^{+3}$ ,  $Mn^{+2}$ ,  $Fe^{+3}$ ,  $Fe^{+2}$ ,  $Co^{+2}$ ,  $Co^{+3}$ ,  $Ni^{+2}$ ,  $Ni^{+3}$ ,  $Ni^{+4}$ ,  $Cu^{+2}$ ,  $Cu^{+3}$ ,  $Zn^{+2}$ ,  $Ga^{+3}$ ,  $Ge^{+4}$ ,  $As^{+5}$ ,  $As^{+3}$ , or  $Zr^{+4}$ .

9. The corrosion-inhibiting seal of claim 1 wherein the valence stabilizer is selected from an inorganic valence stabilizer and an organic valence stabilizer.

10. The corrosion-inhibiting seal of claim 9 wherein the valence stabilizer is the inorganic  
5 valence stabilizer selected from molybdates, tungstates, vanadates, niobates, tantalates, tellurates, periodates, iodates, carbonates, antimonates, stannates, phosphates, nitrates, bromates, sulfates, titanates, zirconates, bismuthates, germanates, arsenates, selenates, borates, aluminates, silicates, or combinations thereof.

10 11. The corrosion-inhibiting seal of claim 10 wherein the valence stabilizer is the inorganic valence stabilizer selected from molybdates, tungstates, vanadates, niobates, tantalates, tellurates, periodates, iodates, carbonates, antimonates, stannates, phosphates, nitrates, bromates, sulfates, or combinations thereof.

15 12. The corrosion-inhibiting seal of claim 9 wherein the valence stabilizer is the organic valence stabilizer selected from monoamines; diamines; triamines; tetraamines; pentamines; hexamines; five- or six-membered heterocyclic rings containing one to four nitrogen atoms optionally having additional nitrogen, sulfur, or oxygen binding sites; five- or six-membered heterocyclic rings containing one or two sulfur atoms and having additional nitrogen binding  
20 sites; five- or six-membered heterocyclic rings containing one or two oxygen atoms and having additional nitrogen binding sites; (two-, three-, four-, six-, eight-, or ten-)membered nitrogen, nitrogen-sulfur, or nitrogen-oxygen macrocyclics; macrocyclic oligothioketones or dithiolenes; diazenes; thio-, amido-, or imido-derivatives of hypophosphoric, phosphoric, or diphosphoric acids and salts; thio-derivatives of hypophosphoric, phosphoric, or diphosphoric acids and salts;  
25 azo compounds, triazenes, formazans, azines, hydrazones, or Schiff Bases containing at least two azo, imine, or azine groups; azo compounds, triazenes, formazans, azines, hydrazones, or Schiff Bases; ortho- (for aryl) or alpha- or beta- (for alkyl) substituted azo compounds, triazenes, formazans, azines, hydrazones, or Schiff Bases; oximes; amidines and imido compounds; dithio ligands; amides; amino acids; N-(thio)acyl 7-aminobenzylidenimines; (thio)hydroxamates;  
30 alpha- or ortho-aminothio(di)carboxylic acids and salts; (thio)semicarbazones; (thio)acyl hydrazones; (thio)carbazones; silylaminoalcohols; thioalkyl amines and imines; hydroxyalkyl

imines; (thio)aryl amines and imines; guanylureas; guanidinoureas; 2-nitrosophenols; 2-nitrophenols; N-nitrosohydroxylamines; 1,3-monothioketones; monothiomalonamides; 2-thioacylacetamides; 2-acylthioacetamides; dithiodicarbonyl diamides; trithiodicarbonyl acids and salts; monothiocarbamates; monothioethers; dithioethers; trithioethers; tetrathioethers;

5 pentathioethers; hexathioethers; disulfides; monophosphines; diphosphines; triphosphines; tetraphosphines; pentaphosphines; hexaphosphines; five- or six-membered heterocyclic rings containing one or two sulfur atoms optionally having additional sulfur, oxygen, or phosphorus binding sites; five- or six-membered heterocyclic rings containing one to three phosphorus atoms optionally having additional phosphorus, nitrogen, oxygen, or sulfur binding sites; five- or six-

10 membered heterocyclic rings containing one to four nitrogen atoms and having additional phosphorus binding sites; five- or six-membered heterocyclic rings containing one or two oxygen atoms and optionally having additional sulfur or phosphorus binding sites; (five-, seven-, or nine-)membered nitrogen, nitrogen-sulfur, or nitrogen-oxygen macrocyclics; (two- to ten-)membered sulfur, sulfur-oxygen, or sulfur-phosphorus macrocyclics, not including oligothioketones or

15 dithiolenes; (two- to ten-)membered phosphorus, nitrogen-phosphorus, or oxygen-phosphorus macrocyclics; (two- to ten-)membered oxygen macrocyclics; thio-, amido-, or imido- derivatives of phosphonic and diphosphonic acids and salts containing no sulfur binding sites; amido-, or imido-derivatives of hypophosphoric, phosphoric, or diphosphoric acids and salts containing no sulfur binding sites; dithioperoxydiphosphoramides; dithioperoxydiphosphoric acids and salts;

20 monothioperoxydiphosphoramides; monothioperoxydiphosphoric acids and salts; monothiophosphoric acids; phosphoro(dithioperoxoic) acids and salts; azo compounds, triazenes, formazans, azines, or Schiff Bases; silylamines; silazanes; guanidines and diguanidines; pyridinaldimines; hydrazones; hydramides; nitriles; thioureas and thioamides; ureas and pseudoureas; biurets; monothio ligands; diketone ligands; dithioperoxydicarbonyl acids and salts;

25 dithioacyl disulfides; tetrathioperoxydicarbonyl diamides; (hexa-, penta-, or tetra-)thioperoxydicarbonyl acids and salts; 1,2-dithiolates; rhodanines; dithiocarbimides; (thio)xanthates; S-(alkyl- or aryl-thio)thiocarboxylic acids and salts; phosphinodithioformates; (thio)borates and (thio)boronates; (thio)arsonic acids and salts; (thio)antimonic acids and salts; phosphine and arsine sulfides or oxides; beta-hydroxyketones and -aldehydes; squaric acids and

30 salts; carbonates; carbamates and carbimides; carbazates; imidosulfurous diamides; sulfurdiimines; thiocarbonyl and mercapto oximes; 2-nitrothiophenols; 2-nitrilo(thio)phenols;

acylcyanamides; imidates; 2-amidinoacetates; beta-ketoamines; 3-aminoacrylamides and 3,3-diaminoacrylamides; 3-aminoacrylic acids and salts and 3-hydroxy-3-aminoacrylic acids and salts; 2-nitroanilines; amine and diazine N-oxides; hydrazides and semicarbazides; (amino- or imino-)aryl phosphines; (thio- or hydroxy-)aryl phosphines; arsines; five- or six-membered  
5 heterocyclic rings containing one arsenic atom optionally having additional arsenic binding sites; (two- to six-)membered arsenic macrocyclics; selenoethers; five- or six-membered heterocyclic rings containing one or two selenium atoms optionally having additional selenium binding sites; (two- to six-)membered selenium macrocyclics; 1,3-diselenoketones; 1,1-diselenolates; diselenocarbamates; selenophosphoric acids and salts; selenocarbonates; cyanide, isocyanide,  
10 and cyanamide ligands; nitrosyl and nitrite ligands; azide ligands; thiolates and selenolates; (thio)cyanate ligands; diene or bicyclic or tricyclic hydrocarbon ligands; carbonyl, halogen, oxo, and hydroxo ligands; or combinations thereof.

13. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is  
15 selected from monoamines; diamines; triamines; tetraamines; pentamines; hexamines; five- or six-membered heterocyclic rings containing one to four nitrogen atoms optionally having additional nitrogen, sulfur, or oxygen binding sites; five- or six-membered heterocyclic rings containing one or two sulfur atoms and having additional nitrogen binding sites; five- or six-membered heterocyclic rings containing one or two oxygen atoms and having additional nitrogen  
20 binding sites; (two-, three-, four-, six-, eight-, or ten-)membered nitrogen, nitrogen-sulfur, or nitrogen-oxygen macrocyclics; macrocyclic oligothioketones or dithiolenes; diazenes; thio-, amido-, or imido-derivatives of hypophosphoric, phosphoric, or diphosphoric acids and salts; azo compounds, triazenes, formazans, azines, hydrazones, or Schiff Bases containing at least two azo, imine, or azine groups; azo compounds, triazenes, formazans, azines, hydrazones, or Schiff  
25 Bases; ortho- (for aryl) or alpha- or beta- (for alkyl) substituted azo compounds, triazenes, formazans, azines, hydrazones, or Schiff Bases; oximes; amidines and imido compounds; dithio ligands; amides; amino acids; N-(thio)acyl 7-aminobenzylidenimines; (thio)hydroxamates; alpha- or ortho-aminothio(di)carboxylic acids and salts; (thio)semicarbazones; (thio)acyl hydrazones; (thio)carbazones; silylaminoalcohols; thioalkyl amines and imines; hydroxyalkyl  
30 imines; (thio)aryl amines and imines; guanylureas; guanidinoureas; biurets; diketone ligands; amido- or imido-derivatives of hypophosphoric, phosphoric, or diphosphoric acids and salts;

beta-hydroxyketones and -aldehydes; squaric acids and salts; carbonates; carbamates and carbimides; 2-nitrosophenols; 2-nitrophenols; N-nitrosohydroxylamines; 1,3-monothioketones; monothiomalonamides; 2-thioacylacetamides; 2-acylthioacetamides; dithiodicarbonyl diamides; trithiodicarboxylic acids and salts; monothiocarbamates; (thio)cyanate ligands; or combinations thereof.

14. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the diazene selected from diazeneformimidamides, diazeneformamides, diazeneformothioamides, diazeneacetimidamides, diazeneacetothioamides, diazeneformimidic acids and salts, diazeneacetimidic acids and salts, diazenecarbothioic acids and salts, diazenecarbodithioic acids and salts, diazeneformimidothioic acids and salts, diazeneformaldehydes, diazeneformothioaldehydes, diazeneacetaldehydes, diazeneacetothioaldehydes, diazenediformamides, diazenediformothioamides, diazenediacetamides, diazenediacetothioamides, diazeneacetimidothioic acids and salts, imidoaldiazenes, diazenediformimidamides, diazenediacetimidamides, diazenediformimidic acids and salts, diazenediacetimidic acids and salts, diazenediformimidothioic acids and salts, diazenediacetimidothioic acids and salts, diazenedicarbothioic acids, diazenedicarbodithioic acids, diazeneformic acids, diazenediformic acids, diazeneacetic acids, diazenediacetic acids, diazenediformaldehydes, diazenediformothioaldehydes, diazenediacetaldehydes, diazenediacetothioaldehydes, diimidoaldiazenes, or combinations thereof.

15. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the thio-, amido-, or imido-derivative of hypophosphoric, phosphoric, or diphosphoric acids and salts selected from phosphoramidimidic triamides, phosphoramidimidic acids and salts, phosphorodiamidimidic acids and salts, phosphorodiamidimidothioic acids and salts, phosphoramidimidothioic acids and salts, phosphorodiamidimidodithioic acids and salts, phosphoramidimidodithioic acids and salts, (di- or mono-)thiohypophosphoric acids and salts, (di- or mono-)thiohypophosphoramides, phosphoramidic acids and salts, phosphorimidic acids and salts, (di- or mono-)thioimidodiphosphoric acids and salts, (di- or mono-)thiohydrazidodiphosphoric acids and salts, (di- or mono-)thioimidodiphosphoramides, (di- or mono-)thiohydrazidodiphosphoramides, phosphoric triamides, (di- or mono-

)thiodiphosphoramides, (di- or mono-)thiodiphosphoric acids and salts, (tetra-, tri-, di-  
)thiophosphoric acids and salts, phosphoro(dithioperoxo)(mono-, di-, or tri-)thioic acids and salts,  
phosphorimido(mono-, di-, or tri-)thioic acids and salts, phosphorothioic triamides,  
phosphoramido(mono, di- or tri-)thioic acids and salts, phosphorodiamido(mono, di- or tri-  
5 )thioic acids and salts, or combinations thereof.

16. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
ortho- (for aryl) or alpha- or beta- (for alkyl) substituted azo compound, triazene, formazan,  
azine, hydrazone, or Schiff Base substituent selected from amino, imino, oximo, diazeno,  
10 hydrazido, thiol, mercapto, thiocarbonyl, hydroxy, carbox, and carbonyl substituents, or  
combinations thereof.

17. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
oxime selected from monooximes, dioximes, carbonyl oximes, imine oximes, hydroxy oximes,  
15 amino oximes, amido oximes, hydrazone oximes, azo oximes, or combinations thereof.

18. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
amidine and imido compound selected from amidines, diamidines, biguanides, biguanidines,  
diamidinomethanes, imidoylguanidines, amidinoguanidines, diformamidine oxides,  
20 diformamidine sulfides, diformamidine disulfides, imidodicarbonimidic acids and salts,  
diimidodicarbonimidic acids and salts, thioimidodicarbonimidic acids and salts,  
thiodiimidodicarbonimidic acids and salts, diimidoylimines, diimidoylhydrazides,  
imidosulfamides, diimidosulfamides, O-amidinocarbamates, O- or S-amidino(mono-, di-, or  
peroxy-)thiocarbamates, N-hydroxy(or N,N'-dihydroxy)amidines, diimidosulfuric acids and  
25 salts, or combinations thereof.

19. The corrosion-inhibiting seal of claim 14 wherein the organic valence stabilizer is the  
dithio ligand selected from dithioimidodialdehydes, dithiohydrazidodialdehydes,  
dithioimidodicarbonic acids and salts, dithiohydrazidodicarbonic acids and salts, 1,3-  
30 dithioketones, 1,2-dithioketones, dithiomalonamides, 2-thioacylthioacetamides, dithioacyl  
sulfides, trithiodicarbonic diamides, (penta-, tetra-, tri-)thiodicarbonic acids and salts, beta-

mercaptothioketones and -aldehydes, N-(aminomethylthiol)thioureas, dithiooxamides, 1,1-dithiolates, (di- or per-)thiomonocarboxylic acids and salts, (tetra- or per-)thiodicarboxylic acids and salts, (di-, tri-, or per-)thiocarbonates, dithiocarbamates (including N-hydroxydithiocarbamates and N-mercaptodithiocarbamates), dithiocarbazates; or combinations  
5 thereof.

20. The corrosion-inhibiting seal of claim 14 wherein the organic valence stabilizer is the amide selected from monoamides, lactams, amidinoamides, guanidinoamides, imidoalamides, polyamides, polylactams, or combinations thereof.

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21. The corrosion-inhibiting seal of claim 14 wherein the organic valence stabilizer is the thio-, amido-, or imido-derivative of phosphonic and diphosphonic acids and salts selected from phosphonitrile amides, phosphonimidic diamides, phosphonamidimidic acids and salts, phosphonamidimidothioic acids and salts, dithioimidodiphosphonic acids and salts,  
15 dithiohydrazidodiphosphonic acids and salts, dithioimidodiphosphonamides, dithiohydrazidodiphosphonamides, dithiodiphosphonamides, dithiodiphosphonic acids and salts, dithioperoxydiphosphonamides, dithioperoxydiphosphonic acids and salts, (di- and tri-)thiophosphonic acids and salts, phosphono(dithioperoxo)thioic acids and salts, phosphono(dithioperoxo)dithioic acids and salts, phosphonimidothioic acids and salts,  
20 phosphonimidodithioic acids and salts, phosphonothioic acids and salts, phosphonanidothioic acids and salts, phosphonamidimidodithioic acids and salts, monothioimidodiphosphonic acids and salts, monothiohydrazidodiphosphonic acids and salts, monothioimidodiphosphonamides, monothiohydrazidodiphosphonamides, monothiodiphosphonamides, monothiodiphosphonic acids and salts, monothioperoxydiphosphonamides, monothioperoxydiphosphonic acids and  
25 salts, monothiophosphonic acids and salts, phosphono(dithioperoxoic) acids and salts, or combinations thereof.

22. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the amido-, or imido-derivative of hypophosphoric, phosphoric, or diphosphoric acids and salts  
30 containing no sulfur binding sites selected from hypophosphoric acids and salts, hypophosphoramides, imidodiphosphoric acids and salts, hydrazidodiphosphoric acids and salts,

imidodiphosphoramides, hydrazidodiphosphoramides, diphosphoramides, or combinations thereof.

23. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
5 amido-, or imido-derivative of phosphonic or diphosphonic acids and salts containing no sulfur  
binding sites selected from imidodiphosphonic acids and salts, hydrazidodiphosphonic acids and  
salts, imidodiphosponamides, hydrazidodiphosponamides, diphosponamides,  
phosphonimidic acids and salts, phosphonamidic acids and salts, phosphonic diamides, or  
combinations thereof.

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24. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
thiourea and thioamide selected from thioureas, thiocarboxamides, thioacylthioureas,  
acylthioureas, thioacylureas, thioaroylthioureas, aroylthioureas, thioaroylureas, thioimides,  
thioguanylureas, guanidinothioureas, amidinothioamides, guanidinothioamides,  
15 imidoylthioamides, 3-aminothioacrylamides, thiohydrazides, thiosemicarbazides, (mono- and di-  
)thiobiurets, (mono- and di-)thioisobiurets, (mono- and di-)thiobiureas, N-  
(aminomethylol)thioureas, N-(aminomethylthiol)ureas, beta-mercaptocarboxamides, or  
combinations thereof.

20 25. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
biuret selected from biurets, triurets, isobiurets, biureas, triureas, acylureas, aroylureas, N-  
(aminomethylol)ureas, or combinations thereof.

26. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the  
25 monothio ligand selected from beta-aminothiones, 3-aminothioacrylic acids and salts, 3-  
mercapto-3-aminothioacrylic acids and salts, N-thioacyl benzylidenimines,  
thioimidodialdehydes, thiohydrazidodialdehydes, thioimidodicarbonic acids and salts,  
thiohydrazidodicarbonic acids and salts, 1,2-monothioketones, trithioperoxydicarbonic diamides,  
dithioperoxydicarbonic diamides, dithiodicarbonic acids and salts, trithioperoxydicarbonic acids  
30 and salts, beta-hydroxythioketones, beta-hydroxythioaldehydes, beta-mercaptoketones, beta-  
mercaptoaldehydes, monothiooxamides, beta-mercaptocarboxylic acids and salts, beta-



mercaptothiocarboxylic acids and salts, beta-hydroxythiocarboxylic acids and salts, S-alkylthiocarboxylic acids and salts, S-arylthiocarboxylic acids and salts, S-alkyldisulfidocarboxylic acids and salts, S-aryldisulfidocarboxylic acids and salts, monothiomonocarboxylic acids and salts, dithiodicarboxylic acids and salts,  
5 monothiocarbonates, monothiocarbazates, monothiocarbimates, mercaptoalcohols, silylmercaptoalcohols, or combinations thereof.

27. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the diketone ligand selected from imidodialdehydes, hydrazidodialdehydes, imidodicarbonic acids  
10 and salts, hydrazidodicarbonic acids and salts, imidodisulfamic acids and salts, imidodisulfuric acids and salts, 1,3-diketones, 1,2-diketones, malonamides, 2-acylacetamides, monothiodicarbonic diamides, monothiodicarbonic acids and salts, dithioperoxydicarbonic acids and salts, trithionic acids and salts, oxamides, dicarboxylic acids, or combinations thereof.

15 28. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the S-(alkyl- or aryl-thio)thiocarboxylic acid and salt selected from S-(alkylthio)thiocarboxylic acids and salts, S-(arylthio)thiocarboxylic acids and salts, S,S-thiobisthiocarboxylic acids and salts, S-(alkyldisulfido)thiocarboxylic acids and salts, S-(aryldisulfido)thiocarboxylic acids and salts, S,S'-disulfidobisthiocarboxylic acids and salts, or combinations thereof.

20 29. The corrosion-inhibiting seal of claim 12 wherein the organic valence stabilizer is the phosphine and arsine sulfide or oxide selected from phosphine P-sulfides, aminophosphine sulfides, arsine As-sulfides, aminoarsine sulfides, phosphine P-oxides, aminophosphine oxides, arsine As-oxides, aminoarsine oxides, or combinations thereof.

25 30. The corrosion-inhibiting seal of claim 12 wherein the solubility in water of the rare earth/valence stabilizer complex is adjusted by an addition of a substituent group on the organic valence stabilizer.

30 31. The corrosion-inhibiting seal of claim 30 wherein the solubility in water is increased by the addition of the substituent group selected from sulfonate groups ( $-\text{SO}_3^-$ ), carboxyl groups (-

CO<sub>2</sub>-), hydroxyl groups (-OH), ester groups (-CO<sub>3</sub>-), carbonyl groups (=C=O), amine groups (-NH<sub>2</sub>), nitrosamine groups (=N-N=O), carbonylnitrene groups (-CO-N), sulfoxide groups (=S=O), sulfone groups (=S[=O]<sub>2</sub>), sulfinyl groups (-N=S=O), sulfodiimines (=S[=NH]<sub>2</sub>), sulfonyl halide groups (-S[=O]<sub>2</sub>X), sulfonamide groups (-S[=O]<sub>2</sub>NH<sub>2</sub>), monohalosulfonamide  
5 groups (-S[=O]<sub>2</sub>NHX), dihalosulfonamide groups (-S[=O]<sub>2</sub>MX<sub>2</sub>), halosulfonate groups (-S[=O]<sub>2</sub>OX), halosulfonate amide groups (=N-S[=O]<sub>2</sub>X), aminosulfonate groups (=N-S[=O]<sub>2</sub>OH), iminosulfonate groups (-N[SO<sub>3</sub><sup>-</sup>]<sub>1-2</sub>), phosphonate groups (-PO<sub>3</sub><sup>-2</sup>), phosphonamide groups (-PO<sub>2</sub>NH<sub>2</sub><sup>-</sup>), phosphondiamide groups (-PO[NH<sub>2</sub>]<sub>2</sub>), aminophosphonate groups (=N-PO<sub>3</sub><sup>-2</sup>), iminophosphonate groups (-N[PO<sub>3</sub><sup>-2</sup>]<sub>1-2</sub>), or combinations thereof.

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32. The corrosion-inhibiting seal of claim 30 wherein the solubility in water is decreased by the addition of the substituent group selected from nitro groups (-NO<sub>2</sub>), perfluoroalkyl groups (-C<sub>x</sub>F<sub>2x+1</sub>), perchloroalkyl groups (-C<sub>x</sub>Cl<sub>2x+1</sub>), nitramine groups (=N-NO<sub>2</sub>), thioketone groups (=C=S), sulfenyl halide groups (-S-X), sulfur dihaloimide groups (-N=SX<sub>2</sub>), or combinations  
15 thereof.

33. The corrosion-inhibiting seal of claim 12 wherein an electrostatic barrier layer of the rare earth/valence stabilizer complex is adjusted by an addition of a substituent group on the organic valence stabilizer.

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34. The corrosion-inhibiting seal of claim 33 wherein the electrostatic barrier layer is increased by the addition of the substituent group selected from ketones (=C=O), thioketones (=C=S), amides (-C[=O]-NR<sub>2</sub>), thioamides (-C[=S]-NR<sub>2</sub>), nitriles or cyano groups (-CN), isocyanides (-NC), nitroso groups (-N=O), thionitroso groups (-N=S), nitro groups (-NO<sub>2</sub>), azido  
25 groups (-N<sub>3</sub>), cyanamide or cyanonitrene groups (=N-CN), cyanate groups (-O-CN), isocyanate groups (-N=C=O), thiocyanate groups (-S-CN), isothiocyanate groups (-N=C=S), nitrosamine groups (=N-N=O), thionitrosamine groups (=N-N=S), nitramine groups (=N-NO<sub>2</sub>), thionitramine groups (=N-NS<sub>2</sub>), carbonylnitrene groups (-CO-N), thiocarbonylnitrene groups (-CS-N), sulfenyl halides (-S-X), sulfoxides (=S=O), sulfones (=S[=O]<sub>2</sub>), sulfinyl groups (-N=S=O), thiosulfinyl  
30 groups (-N=S=S), sulfenyl thiocyanato groups (-S-S-CN), sulfenyl cyanato groups (-S-O-CN), sulfodiimine groups (=S[=NH]<sub>2</sub>), sulfur dihaloimido groups (-N=SX<sub>2</sub>), sulfur oxide dihaloimido

groups ( $-N=S[=O]X_2$ ), aminosulfur oxide trihalide groups ( $=N-S[=O]X_3$ ), sulfonyl azide groups ( $-S[=O]_2N_3$ ), sulfonyl thiocyanate groups ( $-S[=O]_2SCN$ ), sulfonyl cyanate groups ( $-S[=O]_2OCN$ ), sulfonyl cyanide groups ( $-S[=O]_2CN$ ), halosulfonate groups ( $-S[=O]_2OX$ ), phosphonyl thiocyanate groups ( $-P[=O]OHSCN$ ), phosphonyl cyanate groups ( $-P[=O]OHOCN$ ),  
5 phosphonyl cyanide groups ( $-P[=O]OHCN$ ), or combinations thereof.

35. The corrosion-inhibiting seal of claim 1 further comprising a solubility control agent.

36. The corrosion-inhibiting seal of claim 35 wherein the solubility control agent is a cationic  
10 solubility control agent or an anionic solubility control agent.

37. The corrosion-inhibiting seal of claim 36 wherein the solubility control agent is the cationic solubility control agent selected from  $H^+$ ;  $Li^+$ ;  $Na^+$ ;  $K^+$ ;  $Rb^+$ ;  $Cs^+$ ;  $NH_4^+$ ;  $Mg^{+2}$ ;  $Ca^{+2}$ ;  $Sr^{+2}$ ;  $Be^{+2}$ ;  $Ba^{+2}$ ;  $Y^{+3}$ ;  $La^{+3}$ ;  $Ce^{+3}$ ;  $Ce^{+4}$ ;  $Nd^{+3}$ ;  $Pr^{+3}$ ;  $Sc^{+3}$ ;  $Sm^{+3}$ ;  $Eu^{+3}$ ;  $Eu^{+2}$ ;  $Gd^{+3}$ ;  $Tb^{+3}$ ;  $Dy^{+3}$ ;  
15  $Ho^{+3}$ ;  $Er^{+3}$ ;  $Tm^{+3}$ ;  $Yb^{+3}$ ;  $Lu^{+3}$ ;  $Ti^{+4}$ ;  $Zr^{+4}$ ;  $Ti^{+3}$ ;  $Hf^{+4}$ ;  $Nb^{+5}$ ;  $Ta^{+5}$ ;  $Nb^{+4}$ ;  $Ta^{+4}$ ;  $V^{+5}$ ;  $V^{+4}$ ;  $V^{+3}$ ;  $Mo^{+6}$ ;  $W^{+6}$ ;  $Mo^{+5}$ ;  $W^{+5}$ ;  $Mo^{+4}$ ;  $W^{+4}$ ;  $Cr^{+3}$ ;  $Mn^{+2}$ ;  $Mn^{+3}$ ;  $Mn^{+4}$ ;  $Fe^{+2}$ ;  $Fe^{+3}$ ;  $Co^{+2}$ ;  $Co^{+3}$ ;  $Ni^{+2}$ ;  $Ni^{+3}$ ;  $Ni^{+4}$ ;  $Ru^{+2}$ ;  $Ru^{+3}$ ;  $Ru^{+4}$ ;  $Rh^{+3}$ ;  $Ir^{+3}$ ;  $Rh^{+2}$ ;  $Ir^{+2}$ ;  $Pd^{+4}$ ;  $Pt^{+4}$ ;  $Pd^{+2}$ ;  $Pt^{+2}$ ;  $Os^{+4}$ ;  $Cu^+$ ;  $Cu^{+2}$ ;  $Cu^{+3}$ ;  $Ag^+$ ;  $Ag^{+2}$ ;  $Ag^{+3}$ ;  $Au^+$ ;  $Au^{+2}$ ;  $Au^{+3}$ ;  $Zn^{+2}$ ;  $Cd^{+2}$ ;  $Hg^+$ ;  $Hg^{+2}$ ;  $Al^{+3}$ ;  $Ga^{+3}$ ;  $Ga^+$ ;  $In^{+3}$ ;  $In^+$ ;  $Tl^{+3}$ ;  $Tl^+$ ;  $Ge^{+4}$ ;  $Ge^{+2}$ ;  $Sn^{+4}$ ;  $Sn^{+2}$ ;  $Pb^{+4}$ ;  $Pb^{+2}$ ;  $Sb^{+3}$ ;  $Sb^{+5}$ ;  $As^{+3}$ ;  $As^{+5}$ ;  $Bi^{+3}$ ;  $Bi^{+5}$ ; organic compounds containing at least  
20 one  $N^+$  site; organic compounds containing at least one phosphonium site; organic compounds containing at least one arsonium site; organic compounds containing at least one stibonium site; organic compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site; organic compounds containing at least one selenonium site; organic compounds containing at least one iodonium site; quaternary ammonium compounds having a  
25 formula  $NR_4^+$ , where R is an alkyl, aromatic, or acyclic organic constituent; or combinations thereof.

38. The corrosion-inhibiting seal of claim 37 wherein the cationic solubility control agent is selected from  $H^+$ ;  $Li^+$ ;  $Na^+$ ;  $K^+$ ;  $Rb^+$ ;  $Cs^+$ ;  $NH_4^+$ ;  $Mg^{+2}$ ;  $Ca^{+2}$ ;  $Sr^{+2}$ ;  $Y^{+3}$ ;  $La^{+3}$ ;  $Ce^{+3}$ ;  $Ce^{+4}$ ;  $Nd^{+3}$ ;  
30  $Pr^{+3}$ ;  $Sc^{+3}$ ;  $Sm^{+3}$ ;  $Eu^{+3}$ ;  $Eu^{+2}$ ;  $Gd^{+3}$ ;  $Tb^{+3}$ ;  $Dy^{+3}$ ;  $Ho^{+3}$ ;  $Er^{+3}$ ;  $Tm^{+3}$ ;  $Yb^{+3}$ ;  $Lu^{+3}$ ;  $Ti^{+4}$ ;  $Zr^{+4}$ ;  $Ti^{+3}$ ;  $Hf^{+4}$ ;  $Nb^{+5}$ ;  $Ta^{+5}$ ;  $Nb^{+4}$ ;  $Ta^{+4}$ ;  $Mo^{+6}$ ;  $W^{+6}$ ;  $Mo^{+5}$ ;  $W^{+5}$ ;  $Mo^{+4}$ ;  $W^{+4}$ ;  $Mn^{+2}$ ;  $Mn^{+3}$ ;  $Mn^{+4}$ ;  $Fe^{+2}$ ;  $Fe^{+3}$ ;

Co<sup>+2</sup>; Co<sup>+3</sup>; Ru<sup>+2</sup>; Ru<sup>+3</sup>; Ru<sup>+4</sup>; Rh<sup>+3</sup>; Ir<sup>+3</sup>; Rh<sup>+2</sup>; Ir<sup>+2</sup>; Pd<sup>+4</sup>; Pt<sup>+4</sup>; Pd<sup>+2</sup>; Pt<sup>+2</sup>; Cu<sup>+</sup>; Cu<sup>+2</sup>; Cu<sup>+3</sup>; Ag<sup>+</sup>; Ag<sup>+2</sup>; Ag<sup>+3</sup>; Au<sup>+</sup>; Au<sup>+2</sup>; Au<sup>+3</sup>; Zn<sup>+2</sup>; Al<sup>+3</sup>; Ga<sup>+3</sup>; Ga<sup>+</sup>; In<sup>+3</sup>; In<sup>+</sup>; Ge<sup>+4</sup>; Ge<sup>+2</sup>; Sn<sup>+4</sup>; Sn<sup>+2</sup>; Sb<sup>+3</sup>; Sb<sup>+5</sup>; Bi<sup>+3</sup>; Bi<sup>+5</sup>; organic compounds containing at least one N<sup>+</sup> site; organic compounds containing at least one phosphonium site; organic compounds containing at least one stibonium site; organic  
5 compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site; organic compounds containing at least one iodonium site; quaternary ammonium compounds having a formula NR<sub>4</sub><sup>+</sup>, where R is an alkyl, aromatic, or acyclic organic constituent; or combinations thereof.

- 10 39. The corrosion-inhibiting seal of claim 36 wherein the solubility control agent is the anionic solubility control agent selected from fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates, permanganates, fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates,  
15 fluoroaluminates, chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates, nitrates, nitrites, azides, cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates, fluoroantimonates, chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides,  
20 bromates, iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides, cyanocobaltates, cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates, cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates,  
25 nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates, tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides, amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates,  
30 imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates, tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides,

- amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates, stibonates, cyanides, cyanochromates, cyanonickelates, cyanatochromates, cyanatonickelates, thiocyanatochromates, thiocyanatonickelates, cyanamidochromates, cyanamidonickelates,
- 5 nitritonickelates, arsonates, diarsonates, triarsonates, organic selenates, diselenates, triselenates, arsenates, arsenites, fluoroarsenates, chloroarsenates, selenates, selenites, fluorothallates, chlorothallates, iodo mercury anions, chloromercurates, bromomercurates, osmates, fluoronickelates, chromates, Reinecke's salt, vanadates, or combinations thereof.
- 10 40. The corrosion-inhibiting seal of claim 39 wherein the anionic solubility control agent is selected from fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates, permanganates, fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates, fluoroaluminates,
- 15 chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates, nitrates, nitrites, azides, cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates, fluoroantimonates, chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides, bromates,
- 20 iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides, cyanocobaltates, cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates, cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates,
- 25 nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates, tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides, amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates,
- 30 imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates, tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides,

amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates, stibonates, or combinations thereof.

5 41. The corrosion-inhibiting seal of claim 1 further comprising a lubricity agent.

42. The corrosion-inhibiting seal of claim 41 wherein the lubricity agent is selected from molybdenum disulfide, fluorinated hydrocarbons, perfluorinated hydrocarbons, graphite, soft metals, polymers, or combinations thereof.

10

43. The corrosion-inhibiting seal of claim 42 wherein the lubricity agent is the soft metal selected from tin, indium, silver, or combinations thereof.

44. The corrosion-inhibiting seal of claim 1 wherein the corrosion-inhibiting seal is colored.

15

45. The corrosion-inhibiting seal of claim 44 further comprising an agent which improves color-fastness of the corrosion-inhibiting seal.

46. The corrosion-inhibiting seal of claim 45 wherein the agent which improves color-  
20 fastness is selected from an active UV blocker, a passive UV blocker, a brightener, or a combination thereof.

47. The corrosion-inhibiting seal of claim 46 wherein the agent which improves color-  
fastness is the active UV blocker selected from carbon black, graphite, phthalocyanines, or  
25 combinations thereof.

48. The corrosion-inhibiting seal of claim 46 wherein the agent which improves color-  
fastness is the passive UV blocker selected from titanium oxide, tin oxide, lead oxide, silicon  
oxide, silicates, aluminosilicates, or combinations thereof.

30

49. The corrosion-inhibiting seal of claim 46 wherein the agent which improves color-fastness is the brightener selected from sulfonic acids, sulfonates, sulfonamides, sulfonic acids, sulfinates, sulfones, cyanides, nonionic surfactants, or combinations thereof.

5 50. The corrosion-inhibiting seal of claim 44 wherein the color is formed by a dye selected from vat dyes, mordant dyes, lake dyes, disperse dyes, azo dyes, triazine dyes, triphenylmethane dyes, azine dyes, formazan dyes, phthalocyanine dyes, Schiff Base dyes, naturally-occurring dyes, inorganic pigments, or combinations thereof.

10 51. The corrosion-inhibiting seal of claim 45 wherein the agent which improves color-fastness is an agent which prevents smudging.

52. The corrosion-inhibiting seal of claim 51 wherein the agent which prevents smudging is selected from phosphoric acid, metaphosphates, orthophosphates, pyrophosphates,  
15 polyphosphates, or combinations thereof.

53. The corrosion-inhibiting seal of claim 45 wherein the agent which improves color-fastness is a wetting agent.

20 54. The corrosion-inhibiting seal of claim 53 further comprising less than about 5 g/L of the wetting agent.

55. The corrosion-inhibiting seal of claim 53 wherein the wetting agent is a nonionic surfactant.

25

56. A method of making a corrosion-inhibiting sealing bath comprising:  
providing a solvent;  
providing a rare earth source wherein

the rare earth source is selected from a cerium source, a praseodymium  
30 source, a terbium source, or a combination thereof, and  
at least one rare earth source is in the tetravalent oxidation state;

providing a valence stabilizer; and  
combining the rare earth source and the valence stabilizer to form a rare earth/valence stabilizer complex.

5 57. The method of claim 56 wherein the solvent comprises water.

58. The method of claim 56 wherein  
the cerium source is selected from a trivalent cerium source, a tetravalent cerium source,  
or a combination thereof;

10 the praseodymium source is selected from a trivalent praseodymium source, a tetravalent  
praseodymium source, or a combination thereof; and

the terbium source is selected from a trivalent terbium source, a tetravalent terbium  
source, or a combination thereof.

15 59. The method of claim 56 further comprising oxidizing the rare earth source to form the at  
least one rare earth source in the tetravalent oxidation state.

60. The method of claim 59 wherein the rare earth source is oxidized by adding an oxidizer  
to the corrosion-inhibiting sealing bath.

20

61. The method of claim 60 wherein the oxidizer is a dissolved solid, a liquid, or a gas.

62. The method of claim 60 wherein the oxidizer is selected from peroxides, superoxides,  
persulfates, perborates, pernitrites, perphosphates, percarbonates, persilicates, peraluminates,  
25 pertitanates, perzirconates, permolybdates, pertungstates, pervanadates, organic peroxyacid  
derivatives, ozone, hypochlorites, chlorates, perchlorates, nitrates, nitrites, vanadates, iodates,  
hypobromites, chlorites, bromates, permanganates, periodates, dissolved oxygen, dissolved  
chlorine, dissolved fluorine, or combinations thereof.

30 63. The method of claim 59 wherein the rare earth source is oxidized by electrolysis.



64. The method of claim 56 wherein the cerium source is selected from cerium contained within a treated substrate, cerium (III) nitrate, cerium (III) sulfate, cerium (III) perchlorate, cerium (III) chloride, cerium (III) fluoride, cerium (III) bromide, cerium (III) iodide, cerium (III) bromate, cerium (III) fluosilicate, cerium (III) fluotitanate, cerium (III) fluozirconate, cerium  
5 (III) fluoborate, cerium (III) fluoaluminate, cerium (III) formate, cerium (III) acetate, cerium (III) propionate, cerium (III) butyrate, cerium (III) glycolate, cerium (III) lactate, cerium (III) sulfonate, cerium (III) alkyl sulfonate, cerium (III) alkoxysulfonate, cerium (III) aromatic sulfonate, cerium (III) aromatoxy sulfonate, cerium (III) sulfamate, cerium (III) alkyl phosphates, cerium (III) acetylacetonate, ammonium cerium (III) sulfate, ammonium cerium (III)  
10 nitrate, ammonium cerium (III) oxalate, magnesium cerium (III) sulfate, magnesium cerium (III) nitrate, alkali metal cerium (III) nitrate, alkali metal cerium (III) sulfate, cerium (III) carbonate, cerium (III) phosphate, cerium (III) sulfide, cerium (III) fluorocarbonate, cerium (III) benzoate, cerium (III) oxalate, cerium (III) malonate, cerium (III) tartrate, cerium (III) malate, cerium (III) citrate, cerium (III) thiocyanate, cerium (III) salicylate, cerium (III) oxide, cerium (III)  
15 hydroxide, cerium (IV) hydroxide species with a hydroxide content of less than or about 50%, cerium (IV) hydroxysulfate, cerium (IV) hydroxychloride, cerium (IV) hydroxynitrate, cerium (IV) hydroxyphosphate, cerium (IV) hydroxyperchlorate, cerium (IV) hydroxyacetate, cerium (IV) chloride, cerium (IV) fluoride, cerium (IV) perchlorate, cerium (IV) sulfate, cerium (IV) nitrate, cerium (IV) acetate, cerium (IV) propionate, cerium (IV) butyrate, ammonium cerium  
20 (IV) nitrate, ammonium cerium (IV) sulfate, magnesium cerium (IV) nitrate, magnesium cerium (IV) sulfate, alkali metal cerium (IV) nitrate, alkali metal cerium (IV) sulfate, bastnaesite, monazite, xenotime, loparite, lanthanite, rhabdophane, fergusonite, cebaite, aeschynite, lucasite, stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

25

65. The method of claim 56 wherein the praseodymium source is selected from praseodymium contained within a treated substrate, praseodymium nitrate, praseodymium sulfate, praseodymium perchlorate, praseodymium chloride, praseodymium fluoride, praseodymium bromide, praseodymium iodide, praseodymium bromate, praseodymium  
30 fluosilicate, praseodymium fluotitanate, praseodymium fluozirconate, praseodymium fluoborate, praseodymium fluoaluminate, praseodymium formate, praseodymium acetate, praseodymium

propionate, praseodymium lactate, praseodymium benzenesulfonate, praseodymium acetylacetonate, ammonium praseodymium sulfate, ammonium praseodymium nitrate, magnesium praseodymium sulfate, magnesium praseodymium nitrate, alkali metal praseodymium nitrate, alkali metal praseodymium sulfate, bastnaesite, monazite, xenotime,  
5 loparite, lanthanite, rhabdophane, fergusonite, cebaite, aeschynite, lucasite, stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

66. The method of claim 56 wherein the terbium source is selected from terbium contained within a treated substrate, terbium nitrate, terbium sulfate, terbium perchlorate, terbium chloride,  
10 terbium fluoride, terbium bromide, terbium iodide, terbium bromate, terbium fluosilicate, terbium fluotitanate, terbium fluozirconate, terbium fluoborate, terbium fluoaluminate, terbium formate, terbium acetate, terbium propionate, terbium lactate, terbium benzenesulfonate, terbium acetylacetonate, ammonium terbium sulfate, ammonium terbium nitrate, magnesium terbium sulfate, magnesium terbium nitrate, alkali metal terbium nitrate, alkali metal terbium sulfate,  
15 bastnaesite, monazite, xenotime, loparite, lanthanite, rhabdophane, fergusonite, cebaite, aeschynite, lucasite, stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

67. The method of claim 56 wherein the valence stabilizer is selected from an inorganic  
20 valence stabilizer and an organic valence stabilizer.

68. The method of claim 56 further comprising adding a preparative agent to the corrosion-inhibiting sealing bath.

25 69. The method of claim 68 wherein the preparative agent is selected from fluorides, chlorides, bromides, acidic species, hydroxides, or combinations thereof.

70. The method of claim 69 wherein the preparative agent is a fluoride.

30 71. The method of claim 70 wherein the fluoride is selected from fluorozirconates, fluorotitanates, fluorosilicates, fluoroaluminates, fluoroborates, fluorogallates, fluoroindates,

- fluorogermanates, fluorostannates, fluorophosphates, fluoroarsenates, fluoroantimonates, fluorobismuthates, fluorosulfates, fluoroselenates, fluorotellurates, fluorocuprates, fluoroargentates, fluorozincates, fluorohafnates, fluorovanadates, fluoroniobates, fluorotantalates, fluoromolybdates, fluorotungstates, fluoroyttrates, fluorolanthanates,
- 5 fluorocerates, fluoromanganates, fluoroferrates, fluoronickelates, fluorocobaltates, potassium fluoride, potassium hydrogen fluoride, sodium fluoride, sodium hydrogen fluoride, lithium fluoride, lithium hydrogen fluoride, ammonium fluoride, ammonium hydrogen fluoride, hydrofluoric acid, dissolved fluorine, organic fluorides, or combinations thereof.
- 10 72. The method of claim 69 wherein the preparative agent is an acidic species.
73. The method of claim 72 wherein the acidic species is selected from nitric acid, sulfuric acid, phosphoric acid, pyrophosphoric acid, hydrochloric acid, perchloric acid, hydrobromic acid, hydriodic acid, iodic acid, periodic acid, disulfuric acid, selenic acid, telluric acid,
- 15 polyphosphoric acid, cyclophosphoric acid, phytic acid, boric acid, carboxylic acid, phosphonic acid, sulfonic acid, and acidic metal salts of titanium, zirconium, niobium, tantalum, molybdenum, tungsten, vanadium, aluminum, silicon, tin, antimony, bismuth, tellurium, yttrium, lanthanum, or combinations thereof.
- 20 74. The method of claim 56 further comprising providing a solubility control agent.
75. The method of claim 74 wherein the solubility control agent is selected from a cationic solubility control agent and an anionic solubility control agent.
- 25 76. The method of claim 75 wherein the solubility control agent is the cationic solubility control agent selected from  $H^+$ ;  $Li^+$ ;  $Na^+$ ;  $K^+$ ;  $Rb^+$ ;  $Cs^+$ ;  $NH_4^+$ ;  $Mg^{+2}$ ;  $Ca^{+2}$ ;  $Sr^{+2}$ ;  $Be^{+2}$ ;  $Ba^{+2}$ ;  $Y^{+3}$ ;  $La^{+3}$ ;  $Ce^{+3}$ ;  $Ce^{+4}$ ;  $Nd^{+3}$ ;  $Pr^{+3}$ ;  $Sc^{+3}$ ;  $Sm^{+3}$ ;  $Eu^{+3}$ ;  $Eu^{+2}$ ;  $Gd^{+3}$ ;  $Tb^{+3}$ ;  $Dy^{+3}$ ;  $Ho^{+3}$ ;  $Er^{+3}$ ;  $Tm^{+3}$ ;  $Yb^{+3}$ ;  $Lu^{+3}$ ;  $Ti^{+4}$ ;  $Zr^{+4}$ ;  $Ti^{+3}$ ;  $Hf^{+4}$ ;  $Nb^{+5}$ ;  $Ta^{+5}$ ;  $Nb^{+4}$ ;  $Ta^{+4}$ ;  $V^{+5}$ ;  $V^{+4}$ ;  $V^{+3}$ ;  $Mo^{+6}$ ;  $W^{+6}$ ;  $Mo^{+5}$ ;  $W^{+5}$ ;  $Mo^{+4}$ ;  $W^{+4}$ ;  $Cr^{+3}$ ;  $Mn^{+2}$ ;  $Mn^{+3}$ ;  $Mn^{+4}$ ;  $Fe^{+2}$ ;  $Fe^{+3}$ ;  $Co^{+2}$ ;  $Co^{+3}$ ;  $Ni^{+2}$ ;  $Ni^{+3}$ ;  $Ni^{+4}$ ;  $Ru^{+2}$ ;  $Ru^{+3}$ ;  $Ru^{+4}$ ;  $Rh^{+3}$ ;
- 30  $Ir^{+3}$ ;  $Rh^{+2}$ ;  $Ir^{+2}$ ;  $Pd^{+4}$ ;  $Pt^{+4}$ ;  $Pd^{+2}$ ;  $Pt^{+2}$ ;  $Os^{+4}$ ;  $Cu^+$ ;  $Cu^{+2}$ ;  $Cu^{+3}$ ;  $Ag^+$ ;  $Ag^{+2}$ ;  $Ag^{+3}$ ;  $Au^+$ ;  $Au^{+2}$ ;  $Au^{+3}$ ;  $Zn^{+2}$ ;  $Cd^{+2}$ ;  $Hg^+$ ;  $Hg^{+2}$ ;  $Al^{+3}$ ;  $Ga^{+3}$ ;  $Ga^+$ ;  $In^{+3}$ ;  $In^+$ ;  $Tl^{+3}$ ;  $Tl^+$ ;  $Ge^{+4}$ ;  $Ge^{+2}$ ;  $Sn^{+4}$ ;  $Sn^{+2}$ ;  $Pb^{+4}$ ;  $Pb^{+2}$ ;

Sb<sup>+3</sup>; Sb<sup>+5</sup>; As<sup>+3</sup>; As<sup>+5</sup>; Bi<sup>+3</sup>; Bi<sup>+5</sup>; organic compounds containing at least one N<sup>+</sup> site; organic compounds containing at least one phosphonium site; organic compounds containing at least one arsonium site; organic compounds containing at least one stibonium site; organic compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site;  
5 organic compounds containing at least one selenonium site; organic compounds containing at least one iodonium site; quaternary ammonium compounds having a formula NR<sub>4</sub><sup>+</sup>, where R is an alkyl, aromatic, or acyclic organic constituent; or combinations thereof.

77. The method of claim 76 wherein the cationic solubility control agent is selected from H<sup>+</sup>;  
10 Li<sup>+</sup>; Na<sup>+</sup>; K<sup>+</sup>; Rb<sup>+</sup>; Cs<sup>+</sup>; NH<sub>4</sub><sup>+</sup>; Mg<sup>+2</sup>; Ca<sup>+2</sup>; Sr<sup>+2</sup>; Y<sup>+3</sup>; La<sup>+3</sup>; Ce<sup>+3</sup>; Ce<sup>+4</sup>; Nd<sup>+3</sup>; Pr<sup>+3</sup>; Sc<sup>+3</sup>; Sm<sup>+3</sup>; Eu<sup>+3</sup>; Eu<sup>+2</sup>; Gd<sup>+3</sup>; Tb<sup>+3</sup>; Dy<sup>+3</sup>; Ho<sup>+3</sup>; Er<sup>+3</sup>; Tm<sup>+3</sup>; Yb<sup>+3</sup>; Lu<sup>+3</sup>; Ti<sup>+4</sup>; Zr<sup>+4</sup>; Ti<sup>+3</sup>; Hf<sup>+4</sup>; Nb<sup>+5</sup>; Ta<sup>+5</sup>; Nb<sup>+4</sup>; Ta<sup>+4</sup>; Mo<sup>+6</sup>; W<sup>+6</sup>; Mo<sup>+5</sup>; W<sup>+5</sup>; Mo<sup>+4</sup>; W<sup>+4</sup>; Mn<sup>+2</sup>; Mn<sup>+3</sup>; Mn<sup>+4</sup>; Fe<sup>+2</sup>; Fe<sup>+3</sup>; Co<sup>+2</sup>; Co<sup>+3</sup>; Ru<sup>+2</sup>; Ru<sup>+3</sup>; Ru<sup>+4</sup>; Rh<sup>+3</sup>; Ir<sup>+3</sup>; Rh<sup>+2</sup>; Ir<sup>+2</sup>; Pd<sup>+4</sup>; Pt<sup>+4</sup>; Pd<sup>+2</sup>; Pt<sup>+2</sup>; Cu<sup>+</sup>; Cu<sup>+2</sup>; Cu<sup>+3</sup>; Ag<sup>+</sup>; Ag<sup>+2</sup>; Ag<sup>+3</sup>; Au<sup>+</sup>; Au<sup>+2</sup>; Au<sup>+3</sup>; Zn<sup>+2</sup>; Al<sup>+3</sup>; Ga<sup>+3</sup>; Ga<sup>+</sup>; In<sup>+3</sup>; In<sup>+</sup>; Ge<sup>+4</sup>; Ge<sup>+2</sup>; Sn<sup>+4</sup>; Sn<sup>+2</sup>; Sb<sup>+3</sup>; Sb<sup>+5</sup>; Bi<sup>+3</sup>; Bi<sup>+5</sup>;  
15 organic compounds containing at least one N<sup>+</sup> site; organic compounds containing at least one phosphonium site; organic compounds containing at least one stibonium site; organic compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site; organic compounds containing at least one iodonium site; quaternary ammonium compounds having a formula NR<sub>4</sub><sup>+</sup>, where R is an alkyl, aromatic, or acyclic organic constituent; or  
20 combinations thereof.

78. The method of claim 75 wherein the solubility control agent is the anionic solubility control agent selected from fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates,  
25 permanganates, fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates, fluoroaluminates, chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates, nitrates, nitrites, azides, cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates,  
30 fluoroantimonates, chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides,

- bromates, iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides, cyanocobaltates, cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates,
- 5 cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates, nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates, tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides,
- 10 amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates, imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates, tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides, amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates,
- 15 stibonates, cyanides, cyanochromates, cyanonickelates, cyanatochromates, cyanatonickelates, thiocyanatochromates, thiocyanatonickelates, cyanamidochromates, cyanamidonickelates, nitritonickelates, arsonates, diarsonates, triarsonates, organic selenates, diselenates, triselenates, arsenates, arsenites, fluoroarsenates, chloroarsenates, selenates, selenites, fluorothallates, chlorothallates, iodomercury anions, chloromercurates, bromomercurates, osmates,
- 20 fluoronickelates, chromates, Reinecke's salt, vanadates, or combinations thereof.
79. The method of claim 78 wherein the anionic solubility control agent is selected from fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates, permanganates,
- 25 fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates, fluoroaluminates, chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates, nitrates, nitrites, azides, cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates, fluoroantimonates,
- 30 chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides, bromates,

- iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides, cyanocobaltates, cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates,
- 5 cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates, nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates, tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides,
- 10 amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates, imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates, tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides, amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates,
- 15 stibonates, or combinations thereof.

80. The method of claim 56 wherein the corrosion-inhibiting sealing bath has a concentration of cerium, praseodymium, or terbium of between a minimum concentration of about  $1 \times 10^{-4}$  moles/liter cerium, praseodymium, or terbium and a maximum concentration which is a
- 20 maximum solubility of the cerium, praseodymium, or terbium source in the solvent at a temperature of the sealing bath.

81. The method of claim 60 wherein the corrosion-inhibiting sealing bath has a concentration of oxidizer of between a minimum concentration wherein a majority of the cerium,
- 25 praseodymium, or terbium is oxidized to a tetravalent oxidation state and a maximum concentration which is the maximum solubility of the oxidizer in the solvent at a temperature of the sealing bath.

82. The method of claim 70 wherein the corrosion-inhibiting sealing bath has a concentration
- 30 of preparative agent between a minimum concentration, wherein there is a fluoride-to-cerium, fluoride-to-praseodymium, or fluoride-to-terbium ratio of 0.05 and a maximum concentration,

which is a maximum solubility of the preparative agent in the solvent at a temperature of the sealing bath.

83. The method of claim 72 wherein the corrosion-inhibiting sealing bath has a concentration  
5 of preparative agent between a minimum concentration, wherein there is an acidic species-to-cerium, acidic species-to-praseodymium, or acidic species-to-terbium ratio of 0.05 and a maximum concentration, which is a maximum solubility of the preparative agent in the solvent at a temperature of the sealing bath.

10 84. The method of claim 68 wherein the corrosion-inhibiting sealing bath has a concentration of the preparative agent of less than 5.0 M.

85. The method of claim 84 wherein the corrosion-inhibiting sealing bath has a concentration of the preparative agent of less than 0.5 M.

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86. The method of claim 56 wherein the corrosion-inhibiting sealing bath has a concentration of valence stabilizer between a minimum concentration wherein there is a valence stabilizer-to-cerium, valence stabilizer-to-praseodymium, or valence stabilizer-to-terbium ratio of 0.010 and a maximum concentration which is a maximum solubility of the valence stabilizer in the solvent at  
20 a temperature of the sealing bath.

87. The method of claim 56 wherein the corrosion-inhibiting sealing bath has a pH of between about 0 and about 9.

25 88. The method of claim 87 wherein the corrosion-inhibiting sealing bath has a pH of between about 1 and about 8.

89. The method of claim 56 wherein the corrosion-inhibiting sealing bath has a temperature of between about 5°C and about 100°C.

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90. The method of claim 89 wherein the corrosion-inhibiting sealing bath has a temperature of between about 20°C and about 50°C.

91. A method of applying a corrosion-inhibiting seal to a barrier film, comprising:

5 providing the barrier film to be treated;

contacting the barrier film with a first corrosion-inhibiting sealing bath comprising a first solvent and a rare earth source wherein

the rare earth source is selected from a cerium source, a praseodymium source, a terbium source, or a combination thereof, and

10 at least one rare earth source is in the tetravalent oxidation state; and  
contacting the barrier film with a valence stabilizer to form a seal comprising a rare earth/valence stabilizer complex.

92. The method of claim 91 wherein the valence stabilizer is added to the first corrosion-  
15 inhibiting sealing bath.

93. The method of claim 91 wherein the first solvent comprises water.

94. The method of claim 91 further comprising providing a second corrosion-inhibiting  
20 sealing bath comprising a second solvent and the valence stabilizer.

95. The method of claim 94 wherein the second solvent comprises water.

96. The method of claim 91 wherein the barrier film is a coating selected from oxides,  
25 hydroxides, phosphates, carbonates, oxalates, silicates, aluminates, borates, polymers, or combinations thereof.

97. The method of claim 91 wherein  
the cerium source is selected from a trivalent cerium source, a tetravalent cerium source,  
30 or a combination thereof,



the praseodymium source is selected from a trivalent praseodymium source, a tetravalent praseodymium source, or a combination thereof, and

the terbium source is selected from a trivalent terbium source, a tetravalent terbium source, or a combination thereof.

5

98. The method of claim 91 further comprising oxidizing the rare earth source to form the at least one rare earth source in the tetravalent oxidation state.

99. The method of claim 98 wherein the rare earth source is oxidized in the first corrosion-inhibiting sealing bath.

100. The method of claim 98 wherein the rare earth source is oxidized in the seal.

101. The method of claim 98 wherein the rare earth source is oxidized by adding an oxidizer to the first corrosion-inhibiting sealing bath.

102. The method of claim 98 wherein the rare earth source is oxidized by electrolysis.

103. The method of claim 101 wherein the oxidizer is selected from a dissolved solid, a liquid, and a gas.

104. The method of claim 101 wherein the oxidizer is selected from peroxides, superoxides, persulfates, perborates, pernitrites, perphosphates, percarbonates, persilicates, peraluminates, pertitanates, perzirconates, permolybdates, pertungstates, pervanadates, organic peroxyacid derivatives, ozone, hypochlorites, chlorates, perchlorates, nitrates, nitrites, vanadates, iodates, hypobromites, chlorites, bromates, permanganates, periodates, dissolved oxygen, dissolved chlorine, dissolved fluorine, or combinations thereof.

105. The method of claim 91 wherein the cerium source is selected from cerium contained within a treated substrate, cerium (III) nitrate, cerium (III) sulfate, cerium (III) perchlorate, cerium (III) chloride, cerium (III) fluoride, cerium (III) bromide, cerium (III) iodide, cerium (III)

bromate, cerium (III) fluosilicate, cerium (III) fluotitanate, cerium (III) fluozirconate, cerium (III) fluoborate, cerium (III) fluoaluminate, cerium (III) formate, cerium (III) acetate, cerium (III) propionate, cerium (III) butyrate, cerium (III) glycolate, cerium (III) lactate, cerium (III) sulfonate, cerium (III) alkyl sulfonate, cerium (III) alkoxysulfonate, cerium (III) aromatic  
5 sulfonate, cerium (III) aromatoxy sulfonate, cerium (III) sulfamate, cerium (III) alkyl phosphates, cerium (III) acetylacetonate, ammonium cerium (III) sulfate, ammonium cerium (III) nitrate, ammonium cerium (III) oxalate, magnesium cerium (III) sulfate, magnesium cerium (III) nitrate, alkali metal cerium (III) nitrate, alkali metal cerium (III) sulfate, cerium (III) carbonate, cerium (III) phosphate, cerium (III) sulfide, cerium (III) fluorocarbonate, cerium (III) benzoate,  
10 cerium (III) oxalate, cerium (III) malonate, cerium (III) tartrate, cerium (III) malate, cerium (III) citrate, cerium (III) thiocyanate, cerium (III) salicylate, cerium (III) oxide, cerium (III) hydroxide, cerium (IV) hydroxide species with a hydroxide content of less than or about 50%, cerium (IV) hydroxysulfate, cerium (IV) hydroxychloride, cerium (IV) hydroxynitrate, cerium (IV) hydroxyphosphate, cerium (IV) hydroxyperchlorate, cerium (IV) hydroxyacetate, cerium  
15 (IV) chloride, cerium (IV) fluoride, cerium (IV) perchlorate, cerium (IV) sulfate, cerium (IV) nitrate, cerium (IV) acetate, cerium (IV) propionate, cerium (IV) butyrate, ammonium cerium (IV) nitrate, ammonium cerium (IV) sulfate, magnesium cerium (IV) nitrate, magnesium cerium (IV) sulfate, alkali metal cerium (IV) nitrate, alkali metal cerium (IV) sulfate, bastnaesite, monazite, xenotime, loparite, lanthanite, rhabdophane, fergusonite, ceibaite, aeschynite, lucasite,  
20 stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

106. The method of claim 91 wherein the praseodymium source is selected from praseodymium contained within a treated substrate, praseodymium nitrate, praseodymium  
25 sulfate, praseodymium perchlorate, praseodymium chloride, praseodymium fluoride, praseodymium bromide, praseodymium iodide, praseodymium bromate, praseodymium fluosilicate, praseodymium fluotitanate, praseodymium fluozirconate, praseodymium fluoborate, praseodymium fluoaluminate, praseodymium formate, praseodymium acetate, praseodymium propionate, praseodymium lactate, praseodymium benzenesulfonate, praseodymium  
30 acetylacetonate, ammonium praseodymium sulfate, ammonium praseodymium nitrate, magnesium praseodymium sulfate, magnesium praseodymium nitrate, alkali metal

praseodymium nitrate, alkali metal praseodymium sulfate, bastnaesite, monazite, xenotime, loparite, lanthanite, rhabdophane, fergusonite, cebaite, aeschynite, lucasite, stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

- 5 107. The method of claim 91 wherein the terbium source is selected from terbium contained within a treated substrate, terbium nitrate, terbium sulfate, terbium perchlorate, terbium chloride, terbium fluoride, terbium bromide, terbium iodide, terbium bromate, terbium fluosilicate, terbium fluotitanate, terbium fluozirconate, terbium fluoborate, terbium fluoaluminate, terbium formate, terbium acetate, terbium propionate, terbium lactate, terbium benzenesulfonate, terbium  
10 acetylacetonate, ammonium terbium sulfate, ammonium terbium nitrate, magnesium terbium sulfate, magnesium terbium nitrate, alkali metal terbium nitrate, alkali metal terbium sulfate, bastnaesite, monazite, xenotime, loparite, lanthanite, rhabdophane, fergusonite, cebaite, aeschynite, lucasite, stillwellite, samarskite, parisite, gadolinite, fluocerite, cerianite, churchite, or combinations thereof.

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108. The method of claim 91 wherein the valence stabilizer is selected from an inorganic valence stabilizer and an organic valence stabilizer.

109. The method of claim 91 wherein the barrier film is contacted with the first corrosion-  
20 inhibiting sealing bath by a process selected from immersion, spraying, fogging, wiping, and dipping.

110. The method of claim 94 wherein the barrier film is contacted with the second corrosion-  
25 inhibiting sealing bath by a process selected from immersion, spraying, fogging, wiping, and dipping.

111. The method of claim 91 further comprising adding a preparative agent to the first corrosion-inhibiting sealing bath.

- 30 112. The method of claim 111 wherein the preparative agent is selected from fluorides, chlorides, bromides, acidic species, hydroxides, or combinations thereof.

113. The method of claim 112 wherein the preparative agent is a fluoride.

114. The method of claim 113 wherein the fluoride is selected from fluorozirconates, fluorotitanates, fluorosilicates, fluoroaluminates, fluoroborates, fluorogallates, fluorindates,  
5 fluorogermanates, fluorostannates, fluorophosphates, fluoroarsenates, fluoroantimonates, fluorobismuthates, fluorosulfates, fluoroselenates, fluorotellurates, fluorocuprates, fluoroargentates, fluorozincates, fluorohafnates, fluorovanadates, fluoroniobates, fluorotantalates, fluoromolybdates, fluorotungstates, fluoroyttrates, fluorolanthanates, fluorocerates, fluoromanganates, fluoroferrates, fluoronickelates, fluorocobaltates, potassium  
10 fluoride, potassium hydrogen fluoride, sodium fluoride, sodium hydrogen fluoride, lithium fluoride, lithium hydrogen fluoride, ammonium fluoride, ammonium hydrogen fluoride, hydrofluoric acid, dissolved fluorine, organic fluorides, or combinations thereof.

115. The method of claim 112 wherein the preparative agent is an acidic species.

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116. The method of claim 115 wherein the acidic species is selected from nitric acid, sulfuric acid, phosphoric acid, pyrophosphoric acid, hydrochloric acid, perchloric acid, hydrobromic acid, hydriodic acid, iodic acid, periodic acid, disulfuric acid, selenic acid, telluric acid, polyphosphoric acid, cyclophosphoric acid, phytic acid, boric acid, carboxylic acid, phosphonic  
20 acid, sulfonic acid, and acidic metal salts of titanium, zirconium, niobium, tantalum, molybdenum, tungsten, vanadium, aluminum, silicon, tin, antimony, bismuth, tellurium, yttrium, lanthanum, or combinations thereof.

117. The method of claim 91 further comprising contacting the seal comprising the rare  
25 earth/valence stabilizer complex with a solubility control agent.

118. The method of claim 117 wherein the solubility control agent is added to the first corrosion-inhibiting sealing bath.

30 119. The method of claim 117 further comprising a second corrosion-inhibiting sealing bath comprising a second solvent, the valence stabilizer, and the solubility control agent.

120. The method of claim 119 wherein the second solvent is water.

121. The method of claim 117 wherein the solubility control agent is selected from a cationic solubility control agent and an anionic solubility control agent.

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122. The method of claim 121 wherein the solubility control agent is a cationic solubility control agent selected from  $H^+$ ;  $Li^+$ ;  $Na^+$ ;  $K^+$ ;  $Rb^+$ ;  $Cs^+$ ;  $NH_4^+$ ;  $Mg^{+2}$ ;  $Ca^{+2}$ ;  $Sr^{+2}$ ;  $Be^{+2}$ ;  $Ba^{+2}$ ;  $Y^{+3}$ ;  $La^{+3}$ ;  $Ce^{+3}$ ;  $Ce^{+4}$ ;  $Nd^{+3}$ ;  $Pr^{+3}$ ;  $Sc^{+3}$ ;  $Sm^{+3}$ ;  $Eu^{+3}$ ;  $Eu^{+2}$ ;  $Gd^{+3}$ ;  $Tb^{+3}$ ;  $Dy^{+3}$ ;  $Ho^{+3}$ ;  $Er^{+3}$ ;  $Tm^{+3}$ ;  $Yb^{+3}$ ;  $Lu^{+3}$ ;  $Ti^{+4}$ ;  $Zr^{+4}$ ;  $Ti^{+3}$ ;  $Hf^{+4}$ ;  $Nb^{+5}$ ;  $Ta^{+5}$ ;  $Nb^{+4}$ ;  $Ta^{+4}$ ;  $V^{+5}$ ;  $V^{+4}$ ;  $V^{+3}$ ;  $Mo^{+6}$ ;  $W^{+6}$ ;  $Mo^{+5}$ ;  $W^{+5}$ ;  $Mo^{+4}$ ;  $W^{+4}$ ;  $Cr^{+3}$ ;  $Mn^{+2}$ ;  $Mn^{+3}$ ;  $Mn^{+4}$ ;  $Fe^{+2}$ ;  $Fe^{+3}$ ;  $Co^{+2}$ ;  $Co^{+3}$ ;  $Ni^{+2}$ ;  $Ni^{+3}$ ;  $Ni^{+4}$ ;  $Ru^{+2}$ ;  $Ru^{+3}$ ;  $Ru^{+4}$ ;  $Rh^{+3}$ ;  $Ir^{+3}$ ;  $Rh^{+2}$ ;  $Ir^{+2}$ ;  $Pd^{+4}$ ;  $Pt^{+4}$ ;  $Pd^{+2}$ ;  $Pt^{+2}$ ;  $Os^{+4}$ ;  $Cu^+$ ;  $Cu^{+2}$ ;  $Cu^{+3}$ ;  $Ag^+$ ;  $Ag^{+2}$ ;  $Ag^{+3}$ ;  $Au^+$ ;  $Au^{+2}$ ;  $Au^{+3}$ ;  $Zn^{+2}$ ;  $Cd^{+2}$ ;  $Hg^+$ ;  $Hg^{+2}$ ;  $Al^{+3}$ ;  $Ga^{+3}$ ;  $Ga^+$ ;  $In^{+3}$ ;  $In^+$ ;  $Tl^{+3}$ ;  $Tl^+$ ;  $Ge^{+4}$ ;  $Ge^{+2}$ ;  $Sn^{+4}$ ;  $Sn^{+2}$ ;  $Pb^{+4}$ ;  $Pb^{+2}$ ;  $Sb^{+3}$ ;  $Sb^{+5}$ ;  $As^{+3}$ ;  $As^{+5}$ ;  $Bi^{+3}$ ;  $Bi^{+5}$ ; organic compounds containing at least one  $N^+$  site; organic compounds containing at least one phosphonium site; organic compounds containing at least one arsonium site; organic compounds containing at least one stibonium site; organic compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site; organic compounds containing at least one selenonium site; organic compounds containing at least one iodonium site; quarternary ammonium compounds having a formula of  $NR_4^+$ , where R is an alkyl, aromatic, or acyclic organic constituent; or combinations thereof.

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123. The method of claim 122 wherein the cationic solubility control agent is selected from  $H^+$ ;  $Li^+$ ;  $Na^+$ ;  $K^+$ ;  $Rb^+$ ;  $Cs^+$ ;  $NH_4^+$ ;  $Mg^{+2}$ ;  $Ca^{+2}$ ;  $Sr^{+2}$ ;  $Y^{+3}$ ;  $La^{+3}$ ;  $Ce^{+3}$ ;  $Ce^{+4}$ ;  $Nd^{+3}$ ;  $Pr^{+3}$ ;  $Sc^{+3}$ ;  $Sm^{+3}$ ;  $Eu^{+3}$ ;  $Eu^{+2}$ ;  $Gd^{+3}$ ;  $Tb^{+3}$ ;  $Dy^{+3}$ ;  $Ho^{+3}$ ;  $Er^{+3}$ ;  $Tm^{+3}$ ;  $Yb^{+3}$ ;  $Lu^{+3}$ ;  $Ti^{+4}$ ;  $Zr^{+4}$ ;  $Ti^{+3}$ ;  $Hf^{+4}$ ;  $Nb^{+5}$ ;  $Ta^{+5}$ ;  $Nb^{+4}$ ;  $Ta^{+4}$ ;  $Mo^{+6}$ ;  $W^{+6}$ ;  $Mo^{+5}$ ;  $W^{+5}$ ;  $Mo^{+4}$ ;  $W^{+4}$ ;  $Mn^{+2}$ ;  $Mn^{+3}$ ;  $Mn^{+4}$ ;  $Fe^{+2}$ ;  $Fe^{+3}$ ;  $Co^{+2}$ ;  $Co^{+3}$ ;  $Ru^{+2}$ ;  $Ru^{+3}$ ;  $Ru^{+4}$ ;  $Rh^{+3}$ ;  $Ir^{+3}$ ;  $Rh^{+2}$ ;  $Ir^{+2}$ ;  $Pd^{+4}$ ;  $Pt^{+4}$ ;  $Pd^{+2}$ ;  $Pt^{+2}$ ;  $Cu^+$ ;  $Cu^{+2}$ ;  $Cu^{+3}$ ;  $Ag^+$ ;  $Ag^{+2}$ ;  $Ag^{+3}$ ;  $Au^+$ ;  $Au^{+2}$ ;  $Au^{+3}$ ;  $Zn^{+2}$ ;  $Cd^{+2}$ ;  $Al^{+3}$ ;  $Ga^{+3}$ ;  $Ga^+$ ;  $In^{+3}$ ;  $In^+$ ;  $Ge^{+4}$ ;  $Ge^{+2}$ ;  $Sn^{+4}$ ;  $Sn^{+2}$ ;  $Sb^{+3}$ ;  $Sb^{+5}$ ;  $Bi^{+3}$ ;  $Bi^{+5}$ ; organic compounds containing at least one  $N^+$  site; organic compounds containing at least one phosphonium site; organic compounds containing at least one stibonium site; organic compounds containing at least one oxonium site; organic compounds containing at least one sulfonium site; organic compounds containing at least one iodonium site; quarternary ammonium

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compounds having a formula of  $\text{NR}_4^+$ , where R is an alkyl, aromatic, or acyclic organic constituent; or combinations thereof.

124. The method of claim 121 wherein the solubility control agent is the anionic solubility  
5 control agent selected from fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates, permanganates, fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates, fluoroaluminates, chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates,  
10 nitrates, nitrites, azides, cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates, fluoroantimonates, chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides, bromates, iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides,  
15 cyanocobaltates, cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates, cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates, nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates,  
20 tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides, amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates, imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates,  
25 tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides, amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates, stibonates, cyanides, cyanochromates, cyanonickelates, cyanatochromates, cyanatonickelates, thiocyanatochromates, thiocyanatonickelates, cyanamidochromates, cyanamidonickelates,  
30 nitritonickelates, arsonates, diarsonates, triarsonates, organic selenates, diselenates, triselenates, arsenates, arsenites, fluoroarsenates, chloroarsenates, selenates, selenites, fluorothallates,

chlorothallates, iodo mercury anions, chloromercurates, bromomercurates, osmates, fluoronickelates, chromates, Reinecke's salt, vanadates, or combinations thereof.

125. The method of claim 124 wherein the anionic solubility control agent is selected from  
5 fluorotitanates, chlorotitanates, fluorozirconates, chlorozirconates, fluoroniobates, chloroniobates, fluorotantalates, chlorotantalates, molybdates, tungstates, permanganates, fluoromanganates, chloromanganates, fluoroferrates, chloroferrates, fluorocobaltates, chlorocobaltates, fluorozincates, chlorozincates, borates, fluoroborates, fluoroaluminates, chloroaluminates, carbonates, silicates, fluorosilicates, fluorostannates, nitrates, nitrites, azides,  
10 cyanamides, phosphates, phosphites, phosphonates, phosphinites, thiophosphates, thiophosphites, thiophosphonates, thiophosphinites, fluorophosphates, fluoroantimonates, chloroantimonates, sulfates, sulfites, sulfonates, thiosulfates, dithionites, dithionates, fluorosulfates, tellurates, fluorides, chlorides, chlorates, perchlorates, bromides, bromates, iodides, iodates, periodates, heteropolyanions, ferricyanides, ferrocyanides, cyanocobaltates,  
15 cyanocuprates, cyanomanganates, cyanates, cyanatoferrates, cyanatocobaltates, cyanatocuprates, cyanatomanganates, thiocyanates, thiocyanatoferrates, thiocyanatocobaltates, thiocyanatocuprates, thiocyanatomanganates, cyanamides, cyanamidoferrates, cyanamidocobaltates, cyanamidocuprates, cyanamidomanganates, nitritoferrates, nitritocobaltates, azides, (thio)carboxylates, di(thio)carboxylates, tri(thio)carboxylates,  
20 tetra(thio)carboxylates, (thio)phenolates, di(thio)phenolates, tri(thio)phenolates, tetra(thio)phenolates, (thio)phosphonates, di(thio)phosphonates, tri(thio)phosphonates, (thio)phosphonamides, di(thio)phosphonamides, tri(thio)phosphonamides, amino(thio)phosphonates, diamino(thio)phosphonates, triamino(thio)phosphonates, imino(thio)phosphonates, diimino(thio)phosphonates, (thio)sulfonates, di(thio)sulfonates,  
25 tri(thio)sulfonates, (thio)sulfonamides, di(thio)sulfonamides, tri(thio)sulfonamides, amino(thio)sulfonates, diamino(thio)sulfonates, triamino(thio)sulfonates, imino(thio)sulfonates, diimino(thio)sulfonates, (thio)borates, di(thio)borates, (thio)boronates, organic silicates, stibonates, or combinations thereof.

30 126. The method of claim 91 wherein the first corrosion-inhibiting sealing bath has a concentration of cerium, praseodymium, or terbium of between a minimum concentration of

about  $1 \times 10^{-4}$  moles/liter cerium, praseodymium, or terbium and a maximum concentration which is a maximum solubility of the cerium, praseodymium, or terbium source in the first solvent at a temperature of the sealing bath.

- 5 127. The method of claim 98 wherein the first corrosion-inhibiting sealing bath has a concentration of oxidizer between a minimum concentration wherein a majority of the cerium, praseodymium, or terbium is oxidized to a tetravalent oxidation state and a maximum concentration which is the maximum solubility of the oxidizer in the first solvent at a temperature of the sealing bath.

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128. The method of claim 113 wherein the first corrosion-inhibiting sealing bath has a concentration of preparative agent between a minimum concentration, wherein there is a fluoride-to-cerium, fluoride-to-praseodymium, or fluoride-to-terbium ratio of 0.05 and a maximum concentration, which is a maximum solubility of the preparative agent in the first

- 15 solvent at a temperature of the sealing bath.

129. The method of claim 115 wherein the first corrosion-inhibiting sealing bath has a concentration of preparative agent between a minimum concentration, wherein there is an acidic species-to-cerium, acidic species-to-praseodymium, or acidic species-to-terbium ratio of 0.05

- 20 and a maximum concentration, which is a maximum solubility of the preparative agent in the first solvent at a temperature of the sealing bath.

130. The method of claim 111 wherein the first corrosion-inhibiting sealing bath has a concentration of preparative agent of less than 5.0 M.

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131. The method of claim 130 wherein the first corrosion-inhibiting sealing bath has a concentration of preparative agent of less than 0.5 M.

132. The method of claim 91 wherein the first corrosion-inhibiting sealing bath has a concentration of valence stabilizer between a minimum concentration wherein there is a valence stabilizer-to-cerium, valence stabilizer-to-praseodymium, or valence stabilizer-to-terbium ratio

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of 0.010 and a maximum concentration which is a maximum solubility of the valence stabilizer in the first solvent at a temperature of the sealing bath.

133. The method of claim 91 wherein the first corrosion-inhibiting sealing bath has a pH of  
5 between about 0 and about 9.

134. The method of claim 133 wherein the first corrosion-inhibiting sealing bath has a pH of between about 1 and about 8.

10 135. The method of claim 91 wherein the first corrosion-inhibiting sealing bath has a temperature of between about 5°C and about 100°C.

136. The method of claim 135 wherein the first corrosion-inhibiting sealing bath has a temperature of between about 20°C and about 50°C.

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137. A corrosion-inhibiting seal for a barrier film comprising a rare earth element and a valence stabilizer combined to form a rare earth/valence stabilizer complex wherein  
the rare earth element is selected from cerium, praseodymium, terbium, or combinations thereof,

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at least one rare earth element is in the tetravalent oxidation state, and

the rare earth/valence stabilizer complex is sparingly soluble in water at about 25°C and about 760 Torr.

138. A method of making a corrosion-inhibiting sealing bath comprising:

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providing a solvent;

providing a rare earth source wherein

the rare earth source is selected from a cerium source, a praseodymium source, a terbium source, or a combination thereof, and

at least one rare earth source is in the tetravalent oxidation state;

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providing a valence stabilizer; and

combining the rare earth source and the valence stabilizer to form a rare earth/valence stabilizer complex, wherein the rare earth/valence stabilizer complex is sparingly soluble in water at about 25°C and about 760 Torr.

- 5 139. A method of applying a corrosion-inhibiting seal to a barrier film comprising:
- providing the barrier film to be treated;
- contacting the barrier film with a first corrosion-inhibiting sealing bath comprising a first solvent and a rare earth source wherein
- the rare earth source is selected from a cerium source, a praseodymium
- 10 source, a terbium source, or a combination thereof, and
- at least one rare earth source is in the tetravalent oxidation state; and
- contacting the barrier film with a valence stabilizer to form a seal comprising a rare earth/valence stabilizer complex, wherein the rare earth/valence stabilizer complex is sparingly soluble in water at about 25°C and about 760 Torr.

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